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Innovations in Maternal Nutrition

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Abstract

Nutrition plays a major role in maternal and child health. Poor maternal nutritional status has been related to adverse birth outcomes. Maternal nutrition is influenced by many biologic, socioeconomic and demographic factors, which vary widely in different populations. Major adverse birth outcomes are low birth weight, preterm birth and intrauterine growth restriction. Developing nutritional interventions will improve birth outcomes and long-term quality of life and reduce mortality, morbidity and health-care costs. Maternal nutrition is a modifiable risk factor of public health importance.

Keywords: Maternal Nutrition; Micronutrients; Birth Outcome; Interventions.

Introduction

Importance of nutrition in pregnancy

Nutrition maintains maternal energy requirements, provides substrate for the development of new tissues, and builds energy reserves for lactation. Deficiencies lead to increased risk of maternal and child morbidity and leaves the mother in a more severely depleted state for her next pregnancy.

Nutrition plays a major role in maternal and child health. Poor maternal nutritional status has been related to adverse birth outcomes however, the association between maternal nutrition and birth outcome is complex and is influenced by many biologic, socio-economic, and demographic factors, which vary widely in different populations [1].

Understanding the relation between maternal nutrition and birth outcomes may provide a basis for developing nutritional interventions that will improve birth outcomes and long-term quality of life and reduce mortality, morbidity, and health-care costs.

Major adverse birth outcomes are low birth weight, preterm birth, and intrauterine growth restriction (IUGR). These adverse birth outcomes represent the leading causes of neonatal death among children born without congenital anomalies [2, 3] and often result in short and long-term health problems and disabilities [4], including a possible predisposition to chronic disease in adult life [5].

Good nutrition in pregnancy involves more than calories alone. Pregnancy increases the demand for protein, amino acids, omega-3 fatty acids, folic acid, iron, copper and other minerals. While food sources are the best way to get the additional nutrients, vitamins and minerals supplements are often required to help mothers reach the recommended levels. Prenatal vitamins contain recommended nutrient levels needed during pregnancy. Ideally, women should begin taking a multi-vitamin or prenatal vitamin at least one month prior to pregnancy. This is particularly important to ensure intake of folic acid which reduces the risk of spina bifida and other similar complications.

Long-term effects of under nutrition in utero

Under nutrition and other adverse influences arising in fetal life or immediately after birth may have permanent effect on the structure, physiology and metabolism of the body. The effects include altered gene expression, reduced cell number, imbalance between cell types, altered organ structure, changes in the pattern of hormone release and of tissue sensitivity to hormones [6].

The maternal nutritional environment can have lasting consequences for maternal health and can influence the future health of babies. Maternal under nutrition may result in babies who are born small. Low birth weight can lead to complications in the early newborn period and are also associated with increased risk for chronic conditions later in life, including coronary heart disease, hypertension and type-2 diabetes. Obesity is a risk factor for serious complications of pregnancy, gestational diabetes and hypertension in pregnancy. Women who develop these conditions during pregnancy are at risk for the development of type-2 diabetes and heart disease later in life. In addition, babies born to mothers with obesity, gestational diabetes and pre-eclampsia have a higher risk of developing similar conditions themselves as they age into adulthood.

Because maternal nutrition is a critical factor for risk of developing health complications during pregnancy and in the future, steps should be taken to optimize body weight through healthy nutrition and physical activity prior to pregnancy and continued during pregnancy and lactation. The benefits will last a lifetime.

During pregnancy lack of vital nutrients at different stages leads to under nutrition of the baby. This could increase the chances for the baby to develop hypertension and heart disease in the adult life, increased tendency of weight gain, affects intelligence, increases susceptibility to cancer, decreases ability to resist infection.

It has been discovered that the effects of prenatal under-nutrition can be passed down from one generation to another. So what you eat on a daily basis not only affects the health of your own baby but can also affect the health of your grandchildren!

Perinatal nutritional status of the infant has a profound and persistent influence on physical growth, immune competence, neurological development and cognitive function. Interest in prenatal nutrition was awakened by the theory of critical period of development. This theory postulates that particular stages are critical for aspects of foetal development. If they are not successfully negotiated, the damage may be irremediable and course of development irreversibly changes. If the diet is inadequate, maternal reserves begin to be utilized, it is possible that there are energy sparing adaptations that may reduce the maintenance requirements of the mother and allow the energy saved to be used to support fetal growth.

When the maternal diet is inadequate, mother's own nutritional status will suffer. For some nutrients, infant's status is maintained at the expense of the mother; for other nutrients mother and fetus compete more evenly; and for others the infant suffers more consequences of deficiency than the mother.

Maternal health and nutrition in turn are dependent on age, genetic, socio-economic as well as cultural and educational factors. Nutritional demands are high as the growth rate is highest at the fetal stage compared to any other time in life. The fertilized ovum undergoes 42 rounds of cell division prior to birth and only about 5 cycles of division after birth. Evidence indicates that the maternal influence on birth weight is stronger than the paternal one [6].

Effects of Disease and Therapy on Nutritional Requirements and Tolerance

The metabolic response to severe physical injury or major sepsis includes synthesis of acute phase reaction, mounting an immune response, and healing wounds; this response increases the resting energy expenditure by up to two folds and nitrogen requirement up to fourfold. Although in these situations, early fetal demise more likely results from inadequate fluid resuscitation leading to vasoconstriction and impaired perfusion of the uterus and placenta, the increased protein and calorie requirements must be addressed as soon as hemodynamic stability has been achieved, to optimize the maternal recovery and fetal growth.

In some disease states, nutrient tolerance, rather than nutrients requirements may be primarily affected. For example, phenylalanine intolerance in phenylketonuria, carbohydrate intolerance in diabetes mellitus, protein intolerance in renal disease, and fat intolerance in hypertriglyceridemia necessitate dietary medication. Acute pancreatitis, inflammatory bowel disease, may temporarily preclude oral intake. Severe depression or psychiatric disease may severely affect appetite so as to require nutritional intervention.

Occasionally the therapy, rather than the disease, has an impact on the nutritional state. Anticonvulsant can adversely affect folate and vitamin D metabolism. Some antacids interfere with phosphate absorption (owing to aluminum binding) and can cause hypophosphatemia. Diuretics can cause excessive losses of potassium, magnesium, and zinc. Excessive iron supplements can reduce zinc absorption because of competitive inhibition [7].

Nutrition before pregnancy

The incidence of neural tube defects has been reduced by consumption of folate daily beginning of at least one month before conception and may also reduce the incidence of other malformations such as cleft lip, cleft palate, limb deficiencies, cardiac defects, urinary tract defects and omphalocele. Increased folate intake is required for women with a history of medical conditions such as epilepsy or diabetes mellitus or a previous gestation with a neural tube defect [8].

Beneficial pre-pregnancy nutrients

As with most diets, there are chances of over-supplementing, however, as general advice, both state and medical recommendations are that mothers follow instructions listed on particular vitamin packaging as to the correct or recommended daily allowance (RDA). Daily prenatal use of iron substantially improves birth weight, potentially reducing the risk of low birth weight [9].

- Magnesium and zinc supplementation for the binding of hormones at their receptor sites.
- Folic acid supplementation or dietary requirement of foods containing it is required for the regular growth of the follicle.
- Regular vitamin D supplementation decreases the chances of deficiencies in adolescence. More importantly, it is known to reduce the likelihood of rickets with pelvic malformations which make normal delivery impossible.
- Regular vitamin B_{12} supplementation again is known to reduce the chances of infertility and ill health.
- Omega-3 fatty acids increases blood flow to reproductive organs and may help regulate reproductive hormones. Consumption is also known to help prevent premature delivery and low birth weight [10]. The best dietary source of omega-3 fatty acids is oily fish. Some other omega-3 fatty acids not found in fish can be found in foods such as flaxseeds, walnuts, pumpkin seeds, and enriched eggs.

Nutrition during pregnancy

The conception and the subsequent weeks afterwards is the time when it is at its most vulnerable, as it is the time when the organs and systems develop within. The energy used to create these systems comes from the energy and nutrients in the mother's circulation, and around the lining of the womb, such is the reason why correct nutrient intake during pregnancy is so important.

During the early stages of pregnancy, since the placenta is not yet formed, there is no mechanism to protect the embryo from the deficiencies which may be inherent in the mother's circulation. Thus, it is critical that an adequate amount of nutrients and energy is consumed. Additionally, the frequent consumption of nutritious foods helps to prevent nausea, vomiting, and cramps. Supplementing one's diet with foods rich in folic acid, such as oranges and dark green leafy vegetables, helps to prevent neural tube birth defects in the baby, which alludes to pregnancy vegetarianism. Consuming foods rich in iron, such as lean red meat and beans help to prevent anemia and ensure adequate oxygen for the baby. A necessary step for proper diet is to take a daily prenatal vitamins, that ensure their body gets the vitamins and minerals it needs to create a healthy baby. These vitamins contain folic acid, iodine, iron, vitamin A, vitamin D, zinc and calcium [11].

The demand for the energy and nutrients is increased during pregnancy. For well nourished women, only a small amount of additional energy is required because the body adapts to the increased energy requirements and becomes more energy efficient through reduced physical activity and a lowered metabolic rate. Although the average-sized, well-nourished woman requires 2500 Kcal during the last trimester of pregnancy, many women in developing countries restrict their food intake during pregnancy to have smaller infants, on the premise that smaller infants will carry a lower risk of delivery complications. Deficiencies can exist because of losses or malabsorption associated with disease or inadequate intake, lack of knowledge about adequate prenatal nutrition, or dietary taboos associated with pregnancy, with potential adverse consequences for mother as well as newborn infant.

In pregnancy, maternal metabolism is altered by hormones that mediate the redirecting of nutrients to the placenta and mammary gland as well as the transfer of nutrients to the developing fetus. Kidney function changes to handle the clearance of both fetal and maternal metabolic waste, which is associated with increased urinary excretion of water-soluble vitamins (e.g., folate).

Nutrient requirements during pregnancy are usually calculated by adding an increment to the value for non pregnant and non lactating women that covers the cost of fetal growth and development and the associated changes in maternal tissue metabolism. This factorial approach, however, may not necessarily be correct because it does not take into account metabolic changes in absorption or excretion that may compensate for the additional nutrient requirements without the need for an increase in intake [12].

Proteins

The RDA for protein for the average adult is 0.8gm /kg/day. During pregnancy, additional protein is required for deposition in fetal, placental and expanding maternal tissue. The need for extra protein is 1.3gm, 6.1gm and 10.7Gm/day during each of the three trimesters of pregnancy. Protein deficiency usually occurs together with limited intake of energy [7].

Micronutrients

This overview emphasizes 2 relatively neglected issues. The first is that maternal micronutrient status in the periconceptional period, and throughout pregnancy and lactation, should be viewed as a continuum; too often these 3 stages are treated and discussed separately from both a scientific and a public health perspective. Iron and vitamin B_{12} are included as examples to stress how status at conception affects maternal, fetal, and infant status and health until the child is weaned. Multiple micronutrient deficiencies occur simultaneously when diets are poor [13].

Iron Deficiency And Anemia

Though there is still some controversy concerning the optimal stage of pregnancy at which to begin iron supplementation, several studies have now shown that iron stores at conception are a strong predictor of maternal iron status and risk of anemia in later pregnancy. Maternal iron deficiency early in pregnancy has been hypothesized to predict the risk of preterm delivery, based on the fact that risk of conditions such as pre-eclampsia and premature delivery can be predicted based on hormone concentrations established by mid-pregnancy. Also it is very difficult to replenish depleted iron stores once pregnancy is in progress.

While fetal iron status has been assumed to be relatively independent of maternal status during pregnancy, it is becoming clear that maternal iron status strongly affects the iron stores of the infant at birth. In Indonesia, De Pee et al, observed that, compared with a normal birth weight infant born to a mother without anemia, a similar infant born to an anemic mother had a 1.8 times greater risk of developing anemia by 3 to 5 months of age. The highest prevalence of anemia at 3 to 5 months occurred in low birth weight infants whose mothers were anemic during pregnancy, with an odds ratio of 3:7 compared with normal birth weight infants born to non anemic mothers. A substantial number of both observational and iron intervention trials support this relation between infant and maternal iron status.

Another neglected problem is that women are often iron-depleted postpartum. The risk of postpartum anemia was greatest in those who were anemic in pregnancy; 49% of women who were anemic in third trimester developed anemia postpartum compared with 21% who were non anemic. Anemia postpartum is associated with increased risk of postpartum depression. These examples demonstrate that steps should be taken to ensure that maternal iron status is adequate early in pregnancy, throughout pregnancy and during the postpartum period. Inadequate attention has been paid to the problem of risk of iron deficiency in infants born to iron depleted mothers and to maternal iron status postpartum [13].

The prevalence of an anemia is the highest (56%) among adolescents compared with other groups of women of reproductive age. Iron deficiency anemia in the adolescents and pregnant women can be easily corrected by improving awareness of foods that could provide the iron requirements, iron fortified food, and by iron supplements. Maximum brain growth and development occurs during the early years of newborn, especially during first 6 months of life. Adequate iron supplementation in these early stages has been shown to improve the mental development and cognition in children [14].

Calcium

The Current RDA for Calcium is 1200mg/day through age 24, to attain peak bone mass during growth, after which the RDA is reduced to 800mg/day. During pregnancy, the RDA is 1200mg/day.

Hormonally induced extensive adjustments in Calcium Metabolism in Pregnancy are - increase in the rate of bone turnover, decrease in bone resorption, and enhanced intestinal absorption of calcium. These adjustments result in progressive increase in calcium retention, which helps meet fetal requirements.

Multiparous women with poor calcium intake may develop clinical osteomalacia, and their fetus may also develop with decreased bone density. Leg cramps during pregnancy may reflect alterations in calcium or magnesium metabolism. Calcium supplementation of 1to2 gm / day has been associated with a reduced risk of developing hypertensive disorders of pregnancy, including PIH and eclampsia [7].

Recent studies also stress the importance of vitamin D during pregnancy, a particular concern for women in the northern plains. Vitamin D is not found naturally in most foods, so must be taken in foods that are fortified. Because of the health benefits of vitamin D and the high rate of vitamin D deficiency in many people, vitamin D is found in an increasing number of food products. Good sources of vitamin D fortified foods include milk, certain types of yogurt and juice, fortified cereals and breakfast bars.

Vitamin Deficiencies And Homocysteinemia In Pregnancy

There is increasing interest in the fact that homocysteinemia is associated with a greater risk of adverse pregnancy outcomes. Deficiencies of folate, riboflavin, vitamin B_6, or vitamin B_{12} lead to elevated plasma homocysteine (Hcy) concentrations. Women in the highest versus the lowest quartile of plasma Hcy had a history of substantially more placental abruption, still-births, very low birth weight and preterm deliveries, pre-eclampsia, and club-foot and neural tube defects in their offspring. Folic acid supplementation of women in Spain significantly enhanced the physiologic reduction in plasma Hcy that occurs during pregnancy, when the supplements were provided during the 2nd and 3rd trimesters. Plasma Hcy appears to respond to supplementation with folic acid up to about 500 to 600 ìgm of folic acid per day. In addition to poor B vitamin status, other risk factors for elevated plasma Hcy include a high intake of coffee, smoking and no use of vitamin supplements during pregnancy. More attention needs to be paid to vitamin B_{12} status of women during pregnancy and lactation. It has become apparent that there is a high global prevalence of low plasma vitamin B_{12} concentrations in infants, children, and adults. The cause of these low plasma vitamin B_{12} concentrations is most likely low dietary intake of the vitamin. While it is commonly believed that only strict vegetarians (vegans) are at substantial risk of developing vitamin B_{12} deficiency, several studies have revealed that even lacto-ovo vegetarians or individuals who consume low amounts of meat, have lower plasma vitamin B_{12} and are at greater risk of vitamin B_{12} deficiency compared with omnivores. Low maternal plasma vitamin B_{12} has been reported to be associated with increased risk of very early recurrent abortion, neural tube defects and spina bifida.

Poor maternal B-vitamin status may be a major global cause of homocysteinemia and poor pregnancy outcomes. It has not been established how homocysteinemia affects pregnancy outcome adversely, but proposed mechanisms include: Hcy increases oxygen free radical concentrations and reduces nitrous oxide concentrations, leading to endothelial dysfunction, Hcy causes oxidative stress and subsequent placental ischemia; Hcy causes an inflammatory response that is cytotoxic to endothelial cells; B-vitamin deficiencies lead to hypomethylation of DNA and altered gene expression, and Hcy induces apoptosis of endothelial cells; birth defects may be caused by Hcy interference with the N-methyl-D-aspartate receptor system or Hcy is thrombogenic [13].

Folic Acid

Neural tube defects (NTDs) are common among major congenital anomalies. Maternal folic acid supplementation prevents a substantial proportion of NTDs. American college of Obstetricians &

Gynecologists and American academy of Pediatrics, Food and Nutrition Board of the Institute of Medicine also recommended that all women capable of becoming pregnant should consume 0.4mg of folate daily from supplements or fortified foods or a combination of the two in addition to consuming folate from a varied diet [4].

Folic acid plays an important role in nucleic acid synthesis. Marginal folate intake during gestation can impair cellular growth and replication in the fetus & placenta. Continued intake of folic acid also helps in decreasing the risk of other poor pregnancy outcomes. During pregnancy, low concentrations of dietary & circulating folate are associated with increased risk of fetal growth retardation, preterm delivery, and low birth weight of infant [3].

There are periods before and during pregnancy in which specific nutrients are required for optimal development. There is growing evidence that optimal dietary intake of important nutrients like iodine, docosahexaenoic acid (DHA), choline and folate is necessary during pregnancy and lactation [15].

Current Scenario In India

Pregnant women with caloric consumption of less than 50% had a low serum zinc level compared to the women who had a higher calorie intake [16].

Results on dietary intake showed that 18%, 34%, 85% and 57% of the pregnant women were consuming less than 50% of calories, proteins, iron and beta carotene, respectively as compared to their RDA [17].

Pillars of Healthy Pregnancy Diet

For Brain Development – DHA, Choline, Iodine, Folic acid are required. For growth – Calcium, Vitamin D, Protein, Carbohydrates & fats are necessary. For maintaining immunity – Vitamin C, E and zinc need to be supplemented.

DHA – DHA is an omega-3 fatty acid and is derived from alpha-linolenic acid. Docosahexaenoic acid (DHA) has limited capacity for synthesis inside the body. Hence, they are conditionally required in the diet. Major omega-3 fatty acid is needed to build the fetal brain. It accounts for about 40% of poly unsaturated fatty acids in the brain and 60% in the retina. Critical period during which dietary DHA is needed to optimize brain development extends from mid pregnancy into the first year of the life. DHA accumulation in fetal brain is most rapid during the last intrauterine trimester and first year of life [15].

Benefits of DHA

Various studies have shown that a higher maternal DHA status/ cord blood was associated with – longer gestation, higher visual acuity, and better cognitive development in infants. Studies have also shown that women with lower omega-3 fatty acids were 6 times more likely to get depressed during antenatal period. A daily intake of DHA in pregnant and lactating women is recommended to be 200mg.

Choline

Folate is an essential vitamin, whereas choline is a class of nutrients which has limited capacity of synthesis inside the body. Choline is required for membrane synthesis, methylation reactions, and for neurotransmitter synthesis. Maternal dietary deficiency of either choline or folic acid diminishes new nerve formation (neurogenesis) and increases neural cell death in the fetal brain [15].

Choline status during pregnancy influences brain development in fetus. Transport of choline from mother to fetus depletes maternal plasma choline. Demand for choline is so high that stores are depleted. Hence supply of choline is critical during pregnancy. Milk contains high amount of choline. Lactation further depletes tissue stores causing increased maternal demand of choline.

Lack of choline in mother's diet during pregnancy and lactation may have lifelong adverse effects on the child. The Institute of Medicine of the National Academy of Sciences set an adequate intake (AI) level for choline of 425mg / day for women. (18)

Iodine

Iodine deficiency in the mother affects the thyroid function of both the mother and the child. Newborn cretinism is a cause of irreversible mental retardation. Maternal hypothyroxinemia in pregnancy is a key factor in the development of mental retardation in the fetus. Fetus and neonatal sensitivity to low levels of iodine occurs due to their extremely small intra thyroid iodine pool, which consequently results in TSH overstimulation. Much of the thyroid hormone in the fetus comes through the transplacental transfer from the mother. Even transient hypothyroidism around the time of delivery can result in severe mental impairment in the form of cognitive and intellectual impairment in the neonate. Hence by increasing iodine levels in the diet of pregnant woman, this potent impediment to the fetal retardation can be easily overcome. Thyroid hormone deficiency also stunts the physical growth of the offspring and results in cretinism which again can be avoided by maternal iodine supplementation [14].

Adequate iodine supplementation during mid to late pregnancy improves infant cognitive development. It is more beneficial when iodine is given before or early in pregnancy [15].

WHO increased their recommended iodine intake during pregnancy from 200 mcg/day to 250 mcg/day. Studies have shown that children from iodine deficient areas suffered from impaired intellectual and motor skills. Iodine requirement of woman who is fully breast feeding her infant is even higher than that during pregnancy.

Selenium

Selenium is another micronutrient, which is present in the thyroid gland and is essential for its normal functioning. It is present in glutathione peroxidase and superoxide dismutase, antioxidant enzymes responsible for the detoxification of toxic derivatives of oxygen (Hydrogen peroxide and oxygen free radicals). It is also present in type1 iodothyronine 5 deiodinase responsible for the peripheral conversion of thyroxine to triiodothyronine. Selenium deficiency results in accumulation of Hydrogen Peroxide ,which causes fibrosis and destruction of the thyroid gland, resulting in thyroid deficiency. Hence both iodine deficiency and selenium deficiency coexists, and the resulting mental retardation in the neonate can be severe. Hence both iodine and selenium deficiency need to be supplemented during pregnancy [14].

Preliminary studies in some countries, have reported an association between low serum maternal levels and NTDS, sudden infant death syndrome, and first trimester miscarriages. The RDA for the average woman is 55 microgram/day. During pregnancy however, this amount is increased to 65 microgram/day [7].

Immumne Nutrients

Antioxidants

Semenium, Vite, Vit C

Selenium is a trace element which has antioxidant and anti cancer properties.

Vitamin E is a powerful antioxidant. It protects against damaging effects of free radicals. It combats oxidative stress which is an important factor in intrauterine growth retardation, neural tube defects and placental abruption. Vitamin C has a role in immune system.

Vitamine C

Vitamin C concentrations in the plasma and white blood cells (leukocytes) rapidly decline during infections and stress. Supplementation of vitamin C was found to improve components of the human immune system such as antimicrobial and natural killer cell activities, lymphocyte proliferation and other immune reactions. Vitamin C contributes to maintain integrity of cells and thereby protects them against reactive oxygen species generated during the metabolic reactions and the inflammatory response [19].

ZINC

Zinc under nutrition or deficiency was shown to impair cellular intermediates of innate immunity such as phagocytosis, natural killer cell activity and other immune mechanisms[19]. Zinc is an essential trace element for all forms of life. Numerous aspects of cellular metabolism are zinc dependant. Zinc plays an important role in growth and development, the immune response, neurological function and reproduction. Recommended daily allowance is 12-15mg per day. In females, zinc enhances maternal and fetal immunity, improves fertility outcome, and promotes bone growth and metabolism. In males, zinc improves the sperm count.In women at high risk of low birth weight infants, zinc supplementation with 25mg/day, beginning at 19 weeks of gestation was evaluated. There was a greater fetal growth (including head circumference) that was independent of gestational age.

Zinc level decreased with increasing gestational period. The maximum decrease in zinc level was observed during weeks of 35-36 of gestational age.

Neonates of zinc-supplemented mothers were 0.3–0.8 Kg more, depending on the length of time supplemental zinc was provided. If the zinc supplement was initiated in the first trimester, the effect on birth weight was greater. Maternal zinc concentration was shown to affect birth weight and prematurity [20]. Prophylactic doses of 20-25mg of elemental zinc per day have been used in developing countries with World Health Organization (WHO) setting the upper limit of 35mg/day.

Vitamine E

Vitamin E is nature's most effective, lipid soluble, chain-breaking anti oxidant, protecting cell membranes from oxidative damage. Research evidence suggests that an adequate intake of vitamin E and the other anti oxidants can provide protection from the increasingly high free radical concentrations caused by air pollutants and current lifestyle patterns [21]. Vitamin E combats oxidative stress which is important factor in IUGR, neural tube defects and placental abruptions.

Larginine

L-arginine is an amino acid involved in vascular regulation, immune activity, endocrine function, protein production and wound healing. L arginine causes vascular dilatation leading to improved fetoplacental circulation. It also causes uterine relaxation and thus inhibits preterm uterine contractions. L-arginine is the precursor for the nitric oxide (NO). Nitric oxide improves uteroplacental blood circulation. It increases oxygen delivery to the fetus and thus reverses IUGR. In one study, 6gm L-arginine/day was given to 43 pregnant women with IUGR from 30th week of gestation. Out of which, 32 patients showed improvement in the clinical course of pregnancy, and 19 patients showed complete recovery from growth retardation. L-arginine 3gm/day orally accelerated the fetal growth, with mean value of 2526gm. Neonates delivered in L-arginine group revealed higher apgar score, better umbilical cord acid-base status. There was lower incidence of RDS and admission to NICU [22].

Multiple Gestations

Women carrying multiple gestations have increased nutritional requirements. The recommended weight gain for twin gestations is 16-20 kg (35-44 lb). This amount of weight gain requires approximately 630 additional kJ/d (150 kcal/d) over the dietary requirements of singleton pregnancies. Women with triplets should gain 50 lb. Of course, these recommendations should be adjusted for pre pregnancy BMI. Nutrient requirements are also increased in multiple gestations. Routine prenatal vitamin and mineral supplementation is recommended. The suggested amount of folic acid supplementation is 1 mg/d. Elemental iron requirements are often increased, requiring more frequent doses of iron supplements. Lastly, vitamin B-6 requirements are increased. The recommended supplementation for women with multiple pregnancies is 2mg/d.

Issues and Required Action

Many people in developing countries exist on monotonous cereal or legume based diets and has little access to animal products or a variety of fruit and vegetables. Even when such foods are available, cultural beliefs may deny pregnant women access to these foods, rendering them at risk of micronutrient deficiencies. Thus, malnourished pregnant women in developing countries may benefit from prophylactic micronutrient supplementation during pregnancy. Currently, iron or iron and folate supplements are distributed to pregnant women in most developing countries free of charge or at low cost by public health authorities. Nevertheless, few data show that coverage is good or that anemia prevalence rates are declining.

Provision of Micronutrients to Pregnant and Lactating Women

There are 3 main strategies for increasing maternal intake of multiple micronutrients. The first is to improve dietary quality, which in many situations might require increasing consumption of animal source foods, fruits, and vegetables. A number of studies have reported an association between poor maternal diet and a greater risk of pregnancy complications. Also, the relatively few adequately designed intervention studies show that provision of micronutrient rich foods can improve pregnancy outcome .In some situations well designed nutrition education programs can improve dietary quality and pregnancy outcome .

An easier and more common approach is to provide multiple micronutrient supplements to women on their first clinic visit. In an observational study of low income pregnant adolescents in New Jersey, pregnancy outcomes of those who used supplements were compared with those who did not. For women who started taking supplements in their first trimester, there was a substantial reduction in preterm, very preterm, low birth weight and very low birth weight deliveries. If supplements were started in the second trimester, a similar pattern of response was observed, although reduction in complications was somewhat less substantial. The supplement that contained most micronutrients reduced neural tube defects by 90% and birth defects by 50%, compared with the trace element supplement. When the micronutrients were consumed before pregnancy, menstrual periods were more regular, time to conception was shorter, and the rate of conception was increased by 7%. In contrast, multiple micronutrient supplementations of HIV positive pregnant women in Tanzania reduced low birth weight by 44%, preterm delivery by 39%, and IUGR by 43%[13].

Potential benefits of prophylactic prenatal supplementation in the context of developing countries include improving maternal nutritional status, which may, in turn, enhance multiple components of the immune and antioxidant defense systems, reducing pregnancy complications, and reducing the risk of some developmental and common birth defects.

Other four major concerns related to multiple micronutrient supplementations are also relevant to developing countries. First, women eating a good diet are more likely to take supplements regularly than are those at greater risk of micronutrient deficiencies. Second, the micronutrients taken may not be limiting in the diet. Third, some pharmaceutical preparations do not indicate on the package labeling how the micronutrient doses are related to the recommended daily intake. Moreover, less-informed women may take more than the recommended dose on the premise that it is advantageous to the pregnancy outcome and the newborn infant's health. Toxic effects caused by overdosing are a major concern for anyone involved in prenatal care, especially for lipid-soluble vitamins such as A and D that have limited excretion routes. Fourth, other concerns are related to interactions between and among the nutrients. Lonnerdal and Keen classified these into 2 groups. In the first group, deficiency of one element affects the metabolism of another. Copper deficiency, for example, causes low ferroxidase activity, which induces an iron-deficiency like anemia. In the second group, 2 or more trace elements share the same absorptive pathway and a high concentration of one may interfere with the absorption of the other; thus, trace element ratios are important [12]. Lonnerdal, in his review and summary of iron-zinc-copper interactions, notes that a high concentration of iron can interfere with zinc uptake when no dietary ligands are present (i.e., in a fasting state). High iron intakes may interfere with copper absorption if both are taken simultaneously, even when the differences in iron-copper ratios are relatively small. Modest increases in zinc intakes can also affect copper absorption, even with small changes in the ratio. Lonnerdal concluded that these interactions are more likely to occur when the elements are given as a supplement, and that the outcomes can vary greatly depending on whether they are taken with or without a meal. He also notes potential negative effects. For example, modest amounts of zinc may have a positive effect on immune function but higher amounts can interfere with copper and iron absorption, which in turn can adversely affect immune function.

Other micronutrients also interact. For example, some studies found that high plasma folate concentrations decreased the absorption of zinc when zinc intake was low and that a mutual inhibition between folic acid and zinc occurs at the site of intestinal transport,whereas another study did not find this. Selenium and vitamin E interact with each other, and each potentiates the effect of the other.

Babior et al looked at iron absorption after supplementation with high amounts of calcium and magnesium. First trimester iron absorption was lower in fasting pregnant women after they received high dose calcium supplement than after they received a low dose preparation. Calcium is known to inhibit both heme and nonheme iron absorption, and Hallberg recommends that, when needed, calcium supplements be taken separately from meals (e.g., at bedtime). Ascorbic acid is known to enhance iron absorption but only when taken with meals; thus, the addition of vitamin C to iron containing supplements to enhance iron absorption is of little value unless the supplements are taken with meals. Calcium also interacts with zinc, magnesium, and phosphorus, but there is little evidence to suggest high intakes of calcium show evidence of causing the depletion of any of these 3 other minerals or iron.

The issue of interactions clearly has important implications for a multiple micronutrient supplement regimen in pregnancy, especially in vulnerable populations with low intakes. On the one hand, calcium supplementation may be important, but on the other hand, calcium should not be taken at the same time as iron; two separate supplements taken at different times have been suggested. If zinc is included with iron and folate, the supplement should be taken with meals to overcome the inhibitory effect of iron on zinc. If this is done, dietary inhibitors will affect the absorption of the nonheme iron; this can be overcome by including vitamin C, but this is expensive. At the same time, there is the unresolved issue of folate-zinc interactions. The current generally accepted recommendation is that iron and folate supplements should be taken shortly after meals to limit gastric interaction to reduce side effects.

Other concerns

Another important concern is the use of coloring in micronutrient supplements. Although coloring may make the tablets more attractive, it raises safety concerns, particularly regarding children, who may consume the tablets on the premise that they are sweets and thus poison themselves. There is also a need for proper quality assurance systems to ensure bioavailability of the nutrients in supplement preparations.

Programmatic challenges

In addition to the economic constraints, a major programmatic challenge and concern in many developing countries is the lack of well defined government policies on maternal health and nutrition. This is reflected in inadequate funding for reproductive health care programs, an uneven distribution of health centers in rural areas, chronic shortage of skilled health care personnel, logistic problems with the distribution and storage of prenatal supplements, and low morale of health care workers because of low wages and the lack of job satisfaction. Globally, 35% of pregnant women in the developing world do not have prenatal care, 60% do not deliver at a health facility, and 47% do not have a skilled attendant at delivery. Moreover, there are huge regional and sub regional disparities, partly because of a lack of good access to health centers, local culture, and socioeconomic constraints. The logistic problems can be partly overcome by improving both the access to rural communities and the availability of transport to health centers.

Low literacy levels and the frequent inability of physicians in developing countries to translate scientific ideas into local culture also results in many people not necessarily understanding either the need for or the need to take supplements. Clearly, pregnant women need to be provided with information that will reduce or close their knowledge gap about the nutritional value of locally available foodstuffs, what they actually eat, and the need for prophylactic micronutrient supplements. The challenge is how to do all this effectively [12].

Conclusion

Maternal nutrition plays a crucial role in influencing fetal growth and birth outcomes. It is a modifiable risk factor of public health importance in the effort to prevent adverse birth outcomes, particularly among developing/low income populations.

Ideally, micronutrient deficiencies should be prevented or treated before a woman becomes pregnant. This will improve fertility and maternal health. To maximize the reduction of birth defects it is important to prevent maternal micronutrient deficiencies in the periconceptional period, but about 50% of pregnancies are unplanned even in the United States and entry to healthcare may be late. Early prevention of vitamin B deficiencies may also be important to prevent homocysteinemia and iron depletion throughout pregnancy, and to prevent preterm delivery, which is programmed by the middle of gestation.

It is important for professionals working in this field that improving women's nutritional status prior to and during two consecutive pregnancies could be more effective than improving nutritional status only during the critical window of development (during pregnancy and lactation).

Major economic investment in reproductive and child health will go a long way in improving the lifespan of pregnant women and their newborn. Adequate nutrition during preconception period and pregnancy will improve her immunity, prevent congenital anomalies and reduce the incidence of IUGR.

To decide which micronutrients are of greatest concern in developing countries, a more systematic and comprehensive approach is needed that will result in agreement on the objectives of prophylactic multiple micronutrient supplementation, the criteria for identifying and setting concentrations, and the outcomes to be measured. The discussion should differentiate between nutrient needs and the consequences of deficiency at periconceptional period and in pregnancy and how best to address these differing needs. The issue of whether high risk women should be identified and, if so, how this can be done practically also should be revisited.

Additional studies, however, are needed in different geographic regions to identify whether micronutrient supplementation in pregnancy results in functional and measurable outcomes for maternal health and survival. These studies would enable the appropriate intervention strategies to be developed, implemented, and evaluated. Such efforts will require the collaboration and commitment of government agencies, health care providers, nutritionists, research institutions, and the community.

References

1. Villar J, Merialdi M, Gu lmezoglu AM, et al. Nutritional in-terventions during pregnancy for the prevention or treatment of maternal morbidity and preterm delivery: an overview of randomized controlled trials. J Nutr. 2003; 133(5 suppl 2): 1606S–1625S.
2. Bhutta ZA, Darmstadt GL, Hasan BS, et al. Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence. Pediatrics. 2005; 115(2 suppl): 519–617.
3. Scholl TO, Johnson WG. Folic acid: influence on the out-come of pregnancy. Am J Clin Nutr. 2000; 71(5 suppl): 1295S–1303S.
4. Goldenberg RL, Culhane JF. Low birth weight in the United States. Am J Clin Nutr. 2007; 85(2): 584S–590S.
5. Barker DJ. Adult consequences of fetal growth restriction. Clin Obstet Gynecol. 2006; 49(2): 270–283.
6. Aarti Malik Nutrition During Pregnancy and Lactation Obs & Gynae Today VOL VI NO 10 October2001.
7. J B Sharma Nutritional assessment and support during pregnancy obs& Gynae vol V No. 9 September2000; 534-542.
8. Dr. Alka Patil Preconceptional care for Chronic Medical Disorders Indian Journal of Maternal-Fetal & Neonatal Medicine Vol 1 No1 January – June 2014 Page31-39.
9. Haider, BA, Olofin, I, Wang, M, et al. (2013). "Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: systematic review and meta-analysis". *British Medical Journal* 21. doi:10.1136/bmj.f3443.
10. Williamson CS (2006). "Nutrition in pregnancy". *British Nutrition Foundation* 31: 28–59.
11. Laura Riley (2006-02-02). Stephanie Karpinske, ed. *Pregnancy: The Ultimate Week-by-Week Pregnancy Guide*. Meredith Books. pp. 21–22. ISBN 0-696-22221-3.
12. Oladapo A Ladipo Nutrition in Pregnancy: mineral and vitamin supplements *Am J Clin Nutr July 2000 vol. 72 no. 1 280s-290s.*
13. Lindsay H Allen Multiple micronutrients in pregnancy and lactation: an overview Am J Clin Nutr May 2005 vol. 81 no. 5 1206S-1212S©2005 American Society for Clinical Nutrition.
14. Sumitha Nayak Effects of Nutrients On the Outcome of pregnancy.Vol15.No 1.April-June2014.
15. Picciano MF1, McGuire MK. Use of dietary supplements by pregnant and lactating women in North America. Am J Clin Nutr. 2009 Feb; 89(2): 663S-7S. doi: 10.3945/ajcn.2008.26811B. Epub 2008 Dec 10.
16. Piyali Pathak, Umesh Kapil, Sadanand Dwivedi, and Rajvir Singh. Serum zinc levels amongst pregnant women in a rural block of Haryana state, India. Asia Pac J Cln Nutr 2008; 17(2): 276-279.
17. Umesh Kapil, P. Pathak, M. Tandon, C. Singh*, R. Pradhan and S.N. Dwivedi. Micronutrient deficiency disorders amongst pregnant women in three urban community slums in Delhi. Indian Pediatrics 1999; 36: 991-998.
18. Zeisel SH. Nutritional importance of choline for brain development. J Am Coll Nutr. 2004 Dec; 23(6 Suppl): 621S-626S.
19. Eva S. Wintergerst, Silvia Maggin, Dietrich H. Horni. Immune-enhancing role of vitamin C and zinc and effect on clinical conditions. Ann Nutr Metab 2006; 50:85-94.
20. N Khadem, A Mohammadzadeh, A S Farhat, L Valaee, M Khajedaluee, and S M R Parizadeh. Relationship between Low Birth Weight Neonate and Maternal Serum Zinc Concentration. Iran Red Crescent Med J. Apr 2012; 14(4): 240–244.
21. L Packer. Protective role of vitamin E in biological systems. Am J Clin Nutr 1991; 53(4): 1050-55S
22. Mariola Ropacka, Joanna Kowalaska, Katarzyna. The effect of L-arginine on fetal outcome in IUGR fetuses. Archives of Perinatal Medicine 13(3), 30-34,